



**UNIVERSITY OF MARYLAND**

**AGRICULTURAL EXPERIMENT STATION**

**The Technology of Utilizing  
Concentrated Fruit Juices and  
Essences in Ice Cream and  
Related Products**

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# **The Technology of Utilizing Concentrated Fruit Juices and Essences in Ice Cream and Related Products**

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## ABSTRACT

Data have been obtained on the technology of utilizing concentrated fruit juices and essences in ice cream and related products.

The use levels of fruit concentrates and essences of seven different fruits, including peach, apple, strawberry, blueberry, grape, red raspberry and cherry have been established in ice cream, sherbets, ices, ice milk and variegated ice cream.

The amount of flavoring material, basic mix composition, the sugar content and acid adjustment were important factors in obtaining the most desirable flavor.

Many of the fruit concentrates and essences studied proved to be a valuable and economically practical means of improving the flavor of fruit ice cream and related products, either when used to supplement the use of fruit, or in some cases, when used as the only source of fruit flavor.

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## INTRODUCTION

The difficulty in producing a distinct, true fruit flavored ice cream, sherbet, ice, ice milk or variegated product has always been a problem to the ice cream industry. Most ice cream manufacturers maintain a large variety of flavors throughout the entire year in order to meet the preferences of the consumer. Many fruit flavors have never reached their potential degree of success in flavoring ice cream or related products. This has been due primarily to the failure of the delicate flavors to be pronounced enough at the usable flavoring rates of fruit preparations. This lack of flavor in fruit ice cream may be corrected with various degrees of success by the addition of higher levels (above 20% by volume) of fruit. The addition of higher levels of fruit may result in a product of illegal composition in many cases, excessive flavoring costs, and a product with a weak body and a coarse texture. To avoid these difficulties it is a common practice to supplement the fruits with various commercially available artificial flavoring substances. This practice has had the result of destroying the true fruit flavor.

The Eastern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture, has developed processes for making full-flavor concentrated fruit juices and essences (1, 2, 3, 4, 5, 6, 7, 8, 9) which have been used successfully to impart true flavor to beverages, jellies and candies (1, 14).

These concentrated juices and essences have potential value as flavor intensifiers in ice cream (15). Fruit essences and concentrates are now available commercially (10, 11, 12, 13) and their use in ice cream may provide new and profitable outlets for fruits as well as a means of enhancing the flavors of fruit-flavored ice cream, sherbets, ices and ice milk for increased consumer demands of these products.

It was considered important to investigate the flavoring effect of concentrated fruit juices and essences in the manufacture of ice cream, sherbets, ices, ice milk, and variegated ice cream in order to establish information which could lead to new or improved flavors of these frozen dairy foods through the extended utilization of eastern grown fruits.

This bulletin is concerned with the observations made in the conduct of a study of the technology of utilizing full flavored concentrated fruit juices and essences in ice cream and related products, including results on the effect of mix composition, fruit and mix, processing procedures, freezing procedures, rate of adding fruit, flavor evaluation by laboratory and consumer panels and costs. The fruit concentrates of different fruit including peach, apple, strawberry, blueberry, grape, red raspberry and cherry were studied in five sections, each pertinent to the following frozen dairy foods: (1) ice cream, (2) sherbets, (3) ices, (4) ice milk and (5) variegated ice cream. The concentrates and essences used in this work were supplied by the Eastern Utilization Research and Development Division, Agricultural Research Service, U. S. Department of Agriculture.

## EXPERIMENTAL

The flavor effect of peach, apple, strawberry, blueberry, grape, red raspberry and cherry full flavored concentrated fruit juice; apple, grape and strawberry concentrated fruit essence and peach full-flavor concentrated puree fruit products when used as a flavor component in ice cream was studied.

In this study whole fruit ice cream and pureed fruit ice cream (in cases where applicable) were prepared by the batch and continuous freezing process using 10, 12 and 14% fat ice cream mix and at least three flavor supplementation levels for each fruit product and the ice cream was drawn at 70, 90 and 110% overrun.

The flavor effect of the concentrated fruit products was investigated as a flavor component for sherbets. The sherbet was prepared by the batch freezing process, using the standard commercial overrun of 30-40% and at least three flavor supplementation levels for each fruit concentrate.

The investigation was conducted in a like manner for fruit ices and the flavor effect of the concentrated fruit products were studied for ice milk and variegated ice cream.

The flavor supplementation levels were evaluated by a selected laboratory panel consisting of at least five competent ice cream judges to evaluate body, texture and flavor of the flavored ice creams, sherbets, ices, ice milks and variegated ice creams.

The ice cream, sherbets, ices, ice milk and variegated ice cream selected as best by the laboratory panel were submitted to a consumer panel at random to indicate the consumer acceptance of these products.

Storage stability studies were conducted for a two month period, with sampling at weekly intervals on the finished ice cream, sherbets, ices, ice milk and variegated ice cream prepared in accordance with formulations selected as best. The effect of storage on body and texture and flavor was evaluated by the laboratory panel of judges.

Acidity and protein stability data were collected and analyzed on all samples during the storage period.

Quantities and unit costs of all components used in each experimental formula were recorded. Formulas for successful application of concentrated fruit products which gave optimum body and texture and flavor were studied. Storage properties and costs were also evaluated.

Conclusions and recommendations are made regarding the potential of the concentrated fruit products for commercial application in fruit ice cream, sherbets, ices, ice milk and variegated ice cream.

### Composition and Preparation of Basic Mixes

Three ice cream mixes were developed to investigate the effect of fat content and overrun on the flavorability of the fruit concentrates used in this study. These mixes were used for the preparation of fruit ice cream supplemented to various flavoring levels with the appropriate fruit concentrate or essence. The

compositions of these ice cream mixes were as follows:

<i>Constituent</i>	<i>%</i>		
Fat	10.0	12.0	14.0
Milk solids-not fat	11.5	11.0	10.0
Sugar	15.0	15.0	15.0
Stabilizer-emulsifier	0.3	0.3	0.3
Total Solids	36.8	38.3	39.3

The ice cream mix was made from fresh 30% condensed skim milk, 40% cream, cane sugar, stabilizer-emulsifier product and water.

All ice cream mixes were pasteurized at 160° F. for 30 minutes, homogenized at pasteurization temperature at 2000 and 700 pounds pressure per square inch on the first and second stages respectively, cooled to 40° F. by a direct expansion surface cooler and aged for at least eight hours at 40° F. prior to freezing. The mixes were frozen in both the batch and continuous freezer.

Fruit ice cream containing 20% fruit, 70, 90, 110% overrun and different levels of supplementation with fruit concentrates was prepared for each of the 10, 12 and 14% fat mixes. This ice cream was examined to establish the effect of fat content and overrun of ice cream on the flavorability of the fruit concentrates used. The 12% fat mix with 90% overrun was used for all other parts of the ice cream phase of this investigation.

Basic sherbet and ice mixes were used to investigate the flavorability of the various fruit concentrates. The basic mix was supplemented to various flavoring levels with the appropriate fruit concentrate. The composition of the sherbet mix was as follows:

<i>Constituent</i>	<i>%</i>
Cane Sugar	16.0
Corn Syrup Solids	10.0
Stabilizer (Pectin)	0.4
Ice Cream mix (12% fat, 11% m.s.n.f. 15% sugar)*	17.4
Fruit	20.0
Water, acid and color	As required
Total	100.0

\*The sugar supplied by the ice cream mix was included as part of the 16% cane sugar.

The sherbet mix was pasteurized at 160° F. for 30 minutes, cooled by a surface cooler to 40° F. and stored at this temperature until used. The addition of the fruits and the acid adjustment was made to the mix just prior to freezing time. The sherbet was frozen to 35% overrun.

The basic ice formula used in the ice phase of the investigation was as follows:

<i>Constituent</i>	<i>%</i>
Cane Sugar	16.0
Corn Syrup Solids	10.0
Stabilizer (Pectin)	0.4
Fruit	20.0
Water, acid and color	As required
Total	100.0

The ice mix was processed in a manner similar to that used for the sherbets. The ice was frozen to 25% overrun.

The basic ice milk formula used in the ice milk phase of this investigation was as follows:

<i>Constituent</i>	<i>%</i>
Fat	4.0
Milk solids-not fat	12.0
Cane Sugar	15.0
Stabilizer-emulsifier	0.4
Total solids	31.4

The ice milk mix was made from fresh 30% condensed skim milk, 40% cream, cane sugar, stabilizer-emulsifier product and water. The mixes were pasteurized at 160° F. for 30 minutes, homogenized at pasteurization temperature at 2000 and 700 pounds pressure per square inch on the first and second stages respectively, cooled to 40° F. with a surface cooler and aged prior to freezing. The overrun of the ice milk studied was 90%.

A fruit sirup base was used to investigate the flavorability of the various fruit concentrates for variegated ice cream. The base sirup used in making the fruit sirup and the base fruit sirup used in the variegated ice cream were as follows:

<i>Base Sirup</i>		<i>Base Fruit Sirup</i>	
	<i>Pounds</i>		<i>%</i>
Sugar	55	Base Sirup	66.7
Water	42.5	Citric Acid	0.3
Pectin	2.5	Fruit Puree	33.0
Total	100.0	Total	100.0

The fruit sirup was injected into the ice cream at the rate of 20% of the volume of mix.

The basic formulas were developed on the basis of approaching average composition of each of these products as produced in the ice cream industry (16, 17, 18, 19).

### **Fruit Preparations**

Fresh frozen fruit was used in this investigation. The fruit was thawed just prior to use and was stored at 40° F. until used.

The fruit packs used, the fruit-sugar ratio, the rate of use and fruit cost were as follows:

<i>Fruit</i>	<i>Fruit Sugar Ratio</i>	<i>Rate Used Per Cent of Mix</i>	<i>Fruit Cost Per Pound Cents</i>
Sliced Peaches	4:1	20	21
Whole Strawberries	4:1	20	34
Sliced Apples	7:1	20	17
Whole Blueberries	4:1	20	28
Seedless Pured Red Raspberries	4:1	10	34
Whole Sour Cherries	5:1	20	21
Grapes - No Fruit Used			

The 20% level was approximately 9½ pounds of fruit in 4 gallons of mix and the 10% fruit level was 4¾ pounds of fruit in 4¼ gallons of mix.

Investigations have shown that fruit ice cream containing 20% fruit has favorable consumer acceptance (20).

### **Fruit Concentrates**

The following fruit concentrate flavoring materials were used:

<i>Fruit Concentrate</i>	<i>Fruit Equivalent</i>
Peach Juice	1 lb. to 7.0 lbs. peaches (peeled and pitted)
Peach Puree	1 lb. to 6.2 lbs. peaches (peeled and pitted)
Apple Juice	1 lb. to 5.5 lbs. apples (juice)
Apple Essence	1 lb. to 158 lbs. apple juice or 28.7 lbs. concentrate juice
Strawberry Juice	1 lb. to 7.5 lbs. strawberries
Strawberry Preserve Essence	1 lb. to 750 lbs. strawberry preserves
Blueberry Juice	1 lb. to 5.5 lbs. blueberries (juice)
Grape Juice	1 lb. to 3.6 lbs. grapes (juice)
Grape Essence	1 lb. to 81 lbs. sweetened juice
Red Raspberry Juice	1 lb. to 6.7 lbs. red raspberries (juice)
Cherry Juice	1 lb. to 4.9 lbs. sour cherries (juice)

Just before the freezing time, the fruit was measured into the desired quantities. The fruit concentrate or essence addition was made to the fruit before the addition of the fruit to the ice cream. The fruit was added to the ice cream in the whole or pureed form. Whole fruit was added to the partially frozen mix when the batch freezer was used and was added with a fruit feeder when the continuous freezer was used.

Pureed fruit was added to the batch freezer with the mix and when the continuous freezer was used the pureed fruit was added to the mix in the flavor vat.

### **Rate of Flavor Supplementation with Fruit Concentrates**

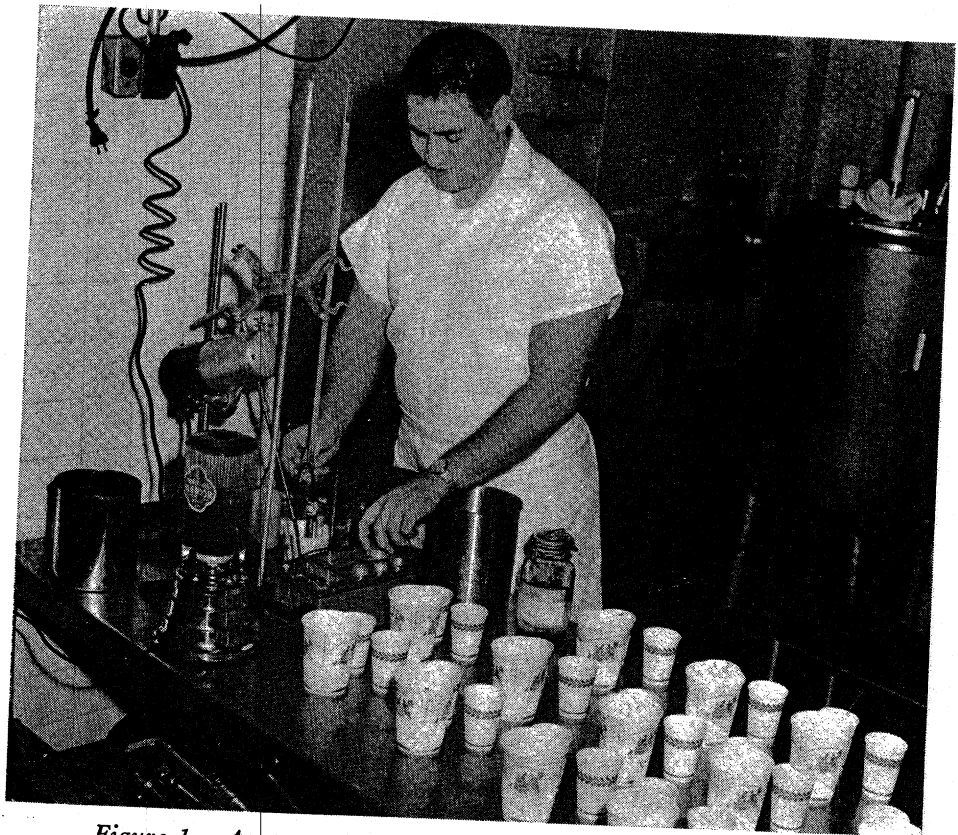
Calculation of the supplementation for the fruit concentration was made according to the following formula:

As an example—if peach puree concentrate (1 lb. equivalent to 6.2 pounds of peaches) is to be used at the 5% supplementation level, the calculation of the amount of peach puree concentrate necessary to be added to 9½ pounds of peaches to flavor ice cream mix would be as follows:

$$\frac{9.5 \text{ lbs.} \times 0.05}{6.2} = 0.077 \text{ lbs. or } 34.96 \text{ grams}$$

The supplementation level was expressed as the percentage of the amount of fruit used in the product being studied.

A laboratory procedure was developed and used to establish the approximate range in rate of supplementation for the various concentrates and essences. This procedure involved the use of a test mix of 300 grams of mix plus 80 grams of fruit which simulated a regular fruit ice cream mix. The appropriate concentrate or essence was added at various levels of supplementation to the test mix on the same basis as it would have been for a regular mix.



*Figure 1. Arrangement and equipment used in the preparation of test mixes of various flavor levels, sugar content, and acidity.*

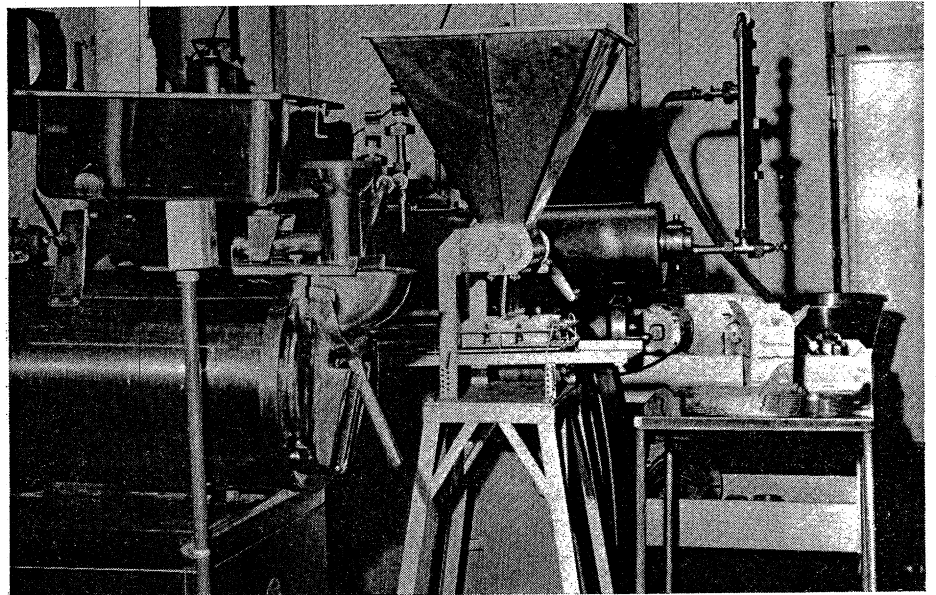
The sugar content and pH were each adjusted on the test mixes to the point where the optimum flavor was obtained as determined by the professional panel of ice cream judges. The sugar content was adjusted by use of a 50% sugar solution. Three grams of the sugar solution were equal to an increase of 1% sugar when replacing 3 grams of the 300 grams of basic mix used. The fruit concentrate or essence was added to the test mix and blended by using a "Lightnin'" mixer. The pH was adjusted by the addition of 50% citric acid solution and determined by using a Model N Beckman pH meter. The test mixes were adjusted in a room maintained at a constant temperature of 40° F. The laboratory procedure was used to develop the use range of fruit concentrates and essences, sugar content and acidity adjustments preferred by the professional panel.

The range in rate of flavor supplementation, sugar content and pH adjustment in the test mixes selected were used as a basis of preparation of mixes from which the best flavor supplementation level was chosen by the professional panel.

#### **Procedure for Determining Best Frozen**

##### **Product by Professional Panel**

The various frozen products investigated were evaluated organoleptically for flavor at the different supplemental levels studied. The form in figure 3 was used in the evaluation of the various products by the professional panel. The best product was determined from observations made by the professional panel where ratings of 1 to 5 were made, with a rating of 3 being "just right."



*Figure 2. Equipment used in freezing and packing products for acceptance studies.*

Judge Name \_\_\_\_\_

Date \_\_\_\_\_

Sample Code No. \_\_\_\_\_

Time of Day \_\_\_\_\_

Taste Panel Evaluation  
for Flavor and Body and Texture  
Flavor

Give each sample a number of indication for the preference of flavor at the three levels of supplementation and for body and texture at the three overruns and at the three fat levels. The number should be given on the following basis:

<u>Flavor</u>	<u>Body and Texture</u>	<u>Overall Classification</u>
1. Completely lacks flavor	1. Much too coarse or too soggy	1. Poor- lacks flavor or too soggy
2. Somewhat lacking in flavor	2. Slightly too coarse or too soggy	2. Fair- slightly lacks flavor or too soggy
3. Just right	3. Just right	3. Just right
4. Slightly too much flavor	4. Slightly too smooth or too fluffy	4. Fair- slightly too much flavor or too smooth or fluffy
5. Much too much flavor	5. Much too smooth or too fluffy	5. Poor- too much flavor or too smooth or fluffy

These samples should be given close attention for flavor intensity at the various overruns and fat levels. The same is true of body and texture.

Please make the overall rating on the basis of the combination of flavor and body and texture observations.

% Fat	Flavor			Body and Texture			Overall Classification		
% Overrun	70	90	110	70	90	110	70	90	110
% Supplement Control									
%									
%									
%									
Remarks									

### Procedure for Consumer Acceptance Studies

The products used in this study consisted of the control product without supplementation with concentrated flavoring as compared with the product selected by the professional panel as having the best rate of supplementation.

The hardened frozen products in three ounce dixie cups were submitted to a consumer panel of at least 100 members selected at random from patrons

of the University of Maryland Dairy Department Salesroom.

The products were evaluated organoleptically by the consumer panel by use of the following form:

Judge Name \_\_\_\_\_

Date \_\_\_\_\_

Time of Day \_\_\_\_\_

Flavor \_\_\_\_\_

**Taste Panel Evaluation for Flavor Preference**

Sample Code No. \_\_\_\_\_

Flavor (Check one only)

- \_\_\_\_\_ completely lacks flavor
- \_\_\_\_\_ somewhat lacking in flavor
- \_\_\_\_\_ just right
- \_\_\_\_\_ slightly too much flavor
- \_\_\_\_\_ much too much flavor

Additional remarks (if any) pertaining to the flavor of this sample \_\_\_\_\_

The samples were coded and arranged in such a manner that each sample would occur first or second in order of tasting an equal number of times for the consumers giving their observations.

The information given the consumer was as follows:

*Observe for flavor only.*

1. Open both samples.
2. Taste both samples.
3. Record your observation by checking the appropriate description of flavor on the sheet provided.
4. Record any additional remarks about flavor in the space provided.

The observations made by the consumer panel were subjected to a simple analysis of variance and the mean value of the consumer ratings was determined (21,22,23).

**Storage Studies**

Eight pint samples of each product selected as best by the professional panel were placed in a storage cabinet and held at a storage temperature of 10° F. The storage samples were evaluated organoleptically by the professional judging panel for flavor, body and texture, and color at weekly intervals for a two-month

storage period. The protein stability of these samples was examined weekly by placing 5 ml. of melted product in a test tube and adding distilled water and 95% alcohol in various portions. The total volume of alcohol plus water was always 10 ml. The amount of alcohol used was varied at 1 ml. intervals until a slight precipitate could be seen on the wall of the test tube after the closed tube had been inverted three times. The ml. of alcohol necessary to form a slight precipitate was recorded as an indication of protein stability.

The pH of the samples was observed weekly during the 8-week storage period by the use of a Model N Beckman pH Meter.

### Flavor Costs

The estimated unit costs of concentrated fruit products used as a basis in the flavor cost analysis were as follows:

<i>Full Flavor Concentrate</i>	<i>Brix Degrees</i>	<i>Cost Per Gallon</i>
Peach Puree	57.2	\$ 8.50
Apple	65	2.50
Strawberry	51	13.50
(50% sucrose)		
Blueberry	67	13.75
(50% blueberry solids)		
Concord Grape	45	3.55
Red Raspberry	51	14.50
Cherry (Montmorency)	67	3.55
<i>Essence</i>	<i>Strength</i>	
Apple	150-fold	\$10.00
Grape	150-fold	11.50
Strawberry Preserves	50 potency	16.00

Although the concentration of the products listed did not always coincide with the concentration of the products used experimentally the values given were used to make adjustments.

# RESULTS

## Ice Cream

### Range in Rate of Supplementation and Best Formulas Established by Test Mix Procedure

Results were obtained on the effect of sugar content on peach flavor from a series of test mixes consisting of a control mix containing 20% fruit with sugar levels ranging from 13 to 20% at 1% intervals. The pH of the mixes was 5.8. The 13 and 14% sugar mixes were described by the professional panel of judges as lacking flavor and sweetness. The mixes with 15 and 16% sugar were rated as slightly lacking flavor and sweetness. The 17% sugar mix was described as being medium full in flavor. When the sugar content was over 17% the mixes were rated as too sweet and lacking in peach flavor because of high sweetness.

The results of these trials indicated that the professional judging panel selected a sugar level of 17% as being most desirable for producing optimum flavor in peach ice cream mix.

**Peach Juice Concentrate:** Trials were conducted using test mixes consisting of a control containing 20% fruit; sugar levels of 15, 16 and 17%; pH values from 5.5 to 6.0; 5.0, 7.5 and 10% supplementation with peach juice concentrate; the addition of all fruit to equal the 7.5% supplemented mix at the various sugar levels and all concentrated juice to equal the control test mix containing approximately 20% fruit at the various sugar levels.

In this series of mixes the 15% sugar level was judged as being just right by all judges of the professional panel and was preferred over mixes with higher sugar levels. The 17% sugar mixes were evaluated as slightly lacking in peach flavor. The mixes consisting of additional fruit to equal the 7.5% supplemented mixes were rated lacking in peach flavor. Those mixes which contained all concentrated juice equivalent to 20% fruit were evaluated as completely lacking in peach flavor. Those mixes with pH values lower than pH 5.6 were regarded as tart while those with pH values above 5.8 were described as lacking flavor.

The formula preferred was that which contained 15 to 16% sugar, with pH of 5.7, and 7.5% peach juice concentrate supplementation.

**Peach Puree Concentrate:** Test mixes were observed consisting of a control containing 20% fruit; sugar levels ranging from 15 to 20% at 1% intervals; with and without pH adjustments from 5.5 to 6.0; 2, 2.5, 3.5, 5.0 and 7.5% supplementation with peach puree concentrate; the addition of all fruit to equal the 5% supplemented mix at the various sugar levels and all peach puree concentrate to equal the 20% fruit in the control test mix at various sugar levels.

In these test mixes the 15% sugar mixes were rated as somewhat lacking in peach flavor. The 16 and 17% sugar mixes were described as being "just right." The 18 and 19% sugar mixes were evaluated as "somewhat lacking" in flavor since the sweetness tended to submerge the peach flavor. The 20%

sugar mix was rated "much too sweet" and lacking in peach flavor.

The desirable flavor obtained by the use of peach puree concentrate in the 5% supplemented test mix could not be equaled by the use of all fruit under any of the conditions observed. The peach puree concentrate when used alone did not give the flavor obtained in the fresh fruit control.

The test mix with 5% supplementation with peach puree concentrate, 16% sugar and pH of 5.7 was selected over all other mixes.

**Apple Juice Concentrate:** The test mixes studied consisted of a control containing 20% fruit; sugar levels of 15, 16 and 17%, with and without pH adjustment; 15, 20, and 25% supplementation with apple juice concentrate; and the addition of all apple juice concentrate to equal the 20% fruit of the control mix at various sugar levels.

The mixes which contained no apple juice concentrate were evaluated as lacking in flavor at all sugar levels. Mixes containing apple juice concentrate equivalent to the 20% fruit of the control test mix were rated as being more pronounced in apple flavor than the control.

The test mix preferred was that which contained 15% sugar, 20% apple juice concentrate supplementation with no pH adjustment (pH 6.2).

**Apple Essence:** Trial mixes prepared were similar to those conducted for apple juice concentrate except apple essence was used at the 20, 25 and 30% levels.

The apple essence proved to give the more desirable flavor when the apple juice concentrate and apple essence test mixes were compared.

The mixes preferred in this trial contained 15 to 16% sugar, 25% apple essence supplementation and with a pH 6.4 (not adjusted).

**Strawberry Juice Concentrate:** When strawberry juice concentrate was used in test mixes to supplement a control containing 20% fruit, all test mixes were evaluated as having almost the same flavor. The sugar level of 15% in the mix was sufficient to provide the desired sweetness.

No difference was noted between the control mix and the supplemented mixes. The flavor of all were rated as just right. The levels of flavor supplementation were 5, 10, 15, 20, 25, 30, 35 and 40% strawberry juice concentrate.

Results of these trials indicate that under the conditions of this study the use of strawberry juice concentrate did not enhance the flavor of strawberry ice cream. The control mix contained 15% sugar, 20% fruit and had a pH of 5.8.

**Strawberry Essence:** Results of trials conducted to establish the use of strawberry essence in flavoring ice cream indicated that strawberry essence did not improve the flavor of strawberry ice cream under the conditions of the study.

**Blueberry Juice Concentrate:** Test mixes were observed, consisting of a control containing 20% fruit; sugar levels of 15, 16 and 17%, with and without pH adjustment; the addition of all fruit to equal the 5.0% supplementation level; and 2.5, 5.0, 7.5 and 10% supplementation blueberry juice concentrate at the various sugar levels and all blueberry juice concentrate to equal the 20% fruit in the control test mix at various sugar levels.

The results of this trial study indicate that two different formulas ranked



*Figure 3. Facilities used in consumer panel studies.*

high in preference. The blueberry test mix with 5 % supplementation with blueberry juice concentrate, 16% sugar, and pH of 5.7 was selected over the other mixes. The test mix obtained by using all concentrate to equal 20% fruit as a source of flavor with 16% sugar produced a cooked blueberry flavor and was highly rated by the professional panel. The cooked blueberry flavor was a consequence of cooking the blueberries before the concentrate was made.

**Grape Juice Concentrate:** When test mixes were studied, using grape juice concentrate at fruit equivalent levels of 5, 10, 15, 20, 25, 28, 30, 35 and 40%; sugar levels of 15, 16 and 17%; with and without pH adjustment, it was found that sugar content and pH adjustment were important in obtaining optimum flavor. The formula selected by the professional panel was that with 15% sugar, with 35% fruit equivalent of grape juice concentrate and a pH of 5.7.

**Grape Essence:** Test mixes were studied which contained 20 to 80% fruit equivalent at 5% intervals of grape essences. Mixes with flavor levels of 30% fruit equivalence or under were rated as being under-flavored while those of 50% fruit equivalence or above were rated as having slightly too much flavor. The results indicate that the mixes selected as best had a sugar level of 15%, grape essence equivalent to 30 to 50% fruit with 35% giving the optimum grape flavor at pH of 5.7. This formula was not presented to the consumer panel as it did not receive predominant agreement from the professional panel.

**Red Raspberry Juice Concentrate:** No satisfactory formula was developed for using red raspberry juice concentrate as a supplement to red raspberry fruit. The concentrated red raspberry juice when used as the only source of flavor at a rate equivalent to 10% fruit was evaluated as very satisfactory.

**Cherry Juice Concentrate:** Examination of test mixes consisting of a control containing 20% fruit and 15% sugar and mixes supplemented with cherry juice concentrate at 10 different levels ranging from 5 to 50% at 5% intervals

showed the pH of each supplemented mix decreased as the per cent of supplementation increased. The control mix was evaluated as lacking in flavor and the 5, 10 and 15% supplemented mixes were considered slightly lacking. The 20, 25 and 30% levels of supplementation were rated as just right while those mixes with over 30% supplementation were criticized as being too acid and having too much flavor.

The mixes containing cherry juice concentrate equivalent to 20% fruit were evaluated as having an acid flavor but slightly lacking in cherry flavor.

The formula preferred contained 15% sugar, supplemented with 20% cherry juice concentrate with a pH of 5.2.

**Discussion of Data on the Effect of Flavor  
Supplementation Levels with Whole and Pureed  
Fruit Prepared by the Batch and Continuous  
Freezer, Various Fat Contents, and Different  
Overruns on the Flavor of the Finished Ice Cream**

Results of the investigation of each of the flavors of ice cream studied (when processed in each of the three basic mixes using three levels of supplementation for all ice creams and overruns of 70, 90 and 110%) show no differences in flavor characteristics as affected by type of freezer, either batch or continuous.

The preparation of the fruit, either whole or pureed, showed little influence in the flavorability of the fruit concentrate studied. The body and texture properties of the ice cream possessed the typical differences in the resultant products of those frozen in a batch freezer as compared to those frozen in a continuous freezer. However, these differences did not affect the flavor properties of the ice cream: the ice cream frozen in a batch freezer could readily be selected from the ice cream frozen in a continuous freezer because of the body and texture characteristics but not on the basis of flavor.

The fat content of the ice cream in products containing 10, 12 and 14% fat did not have an apparent influence on the flavor intensity of the ice cream. The body and texture differences of a high fat ice cream as compared with a lower fat ice cream were apparent in the ice cream of different fat contents but these differences did not affect the flavor properties of the ice cream flavored at the various flavoring levels.

Overrun did not influence the flavoring properties of the resultant ice cream. Ice creams with 70, 90 and 110% overrun could be detected by body and texture characteristics but differences in flavoring at the same flavor supplementation level at the different overruns were not apparent.

The lack of differences in flavoring at the same flavoring level at different overruns was probably due to the fact that a definite amount of flavoring was incorporated into a definite weight of ice cream regardless of overrun. The relationship of the amount of flavor to a given weight of ice cream was the important factor in influencing flavor intensity rather than the volume of ice cream.

Fat content, overrun and type of freezer influenced the body and texture of the resultant products but were not important factors in the flavorability of the resultant supplemental flavored ice cream.

Since the fat content did not show any great influence on fruit flavor intensity it seemed logical that consumer studies should be conducted at the best flavor levels, using 12% fat ice cream. In cases where the higher fat contents were preferred, this preference seemed to be influenced more by body and texture than by flavor.

#### **Flavor Supplementation Levels for Ice Cream Chosen by Professional Panel**

The best levels of flavor supplementation for the concentrated fruit juices and essences in ice cream as established by the professional panel were as follows:

**Peach Juice Concentrate:** The best formula consisted of 16% sugar in the mix, pH adjustment to 5.7 with 7.5% fruit equivalent supplementation of peach juice concentrate.

**Peach Puree Concentrate:** The best formula was that with 16% sugar in the mix, pH adjustment to 5.7, with 5.0% fruit equivalent supplementation peach puree concentrate.

**Apple Juice Concentrate:** The formula preferred consisted of 15% sugar in the mix, pH adjustment to 6.2, with 20% fruit equivalent supplementation with apple juice concentrate.

**Apple Essence:** The formula preferred contained 15% sugar, pH of 6.4 and 25% fruit equivalent supplementation with apple essence.

**Strawberry Juice Concentrate:** No satisfactory flavor supplementation level could be established.

**Strawberry Essence:** No satisfactory flavor supplementation level could be established.

**Blueberry Juice Concentrate:** The formula preferred consisted of 16% sugar in the mix, pH adjustment of 5.7, and fruit concentration supplementation of 5% fruit equivalent with blueberry juice concentrate.

**Grape Juice Concentrate:** The formula selected was that with 15% sugar in the mix, 35% fruit equivalent of grape juice concentrate, and a pH of 5.7.

**Grape Essence:** No satisfactory flavor supplementation level could be established by the professional panel.

**Red Raspberry Juice Concentrate:** No satisfactory supplementation level could be established.

**Cherry Juice Concentrate:** The formula preferred contained 15% sugar in the mix, pH of 5.2, supplemented with 15% fruit equivalent of cherry juice concentrate.

Results of the professional judging panel showed that improved flavors or acceptable new flavors of ice cream could be produced by the use of concentrated peach puree, concentrated peach juice, blueberry, cherry, apple and grape juice concentrate. Results failed to show flavor improvement when strawberry

Table 1. Consumer evaluation of control and flavor supplemented ice cream

Flavor	Amount of Fruit %	Flavor Suppl. Fruit Equiv. %	Consumer rating					Mean value
			(1)	(2)	(3)	(4)	(5)	
			Completely lacking	Somewhat lacking	Just right	Somewhat too much	Much too much	
			Number of consumers					
<i>Peach</i>								
Control	20	—	6	50	45	8	0	2.50
Peach Juice Concentrate	20	7.5	6	48	51	3	1	2.50
Control	20	—	3	50	47	6	0	2.51
Peach Puree Concentrate	20	5.0	3	57	39	7	0	2.43
<i>Apple</i>								
Control	20	—	16	61	21	4	0	2.06
Apple Juice Concentrate	20	20.0	3	34	61	4	0	2.58*
Control	20	—	14	53	30	3	0	2.25
Apple Essence	20	25.0	11	44	42	3	0	2.38
<i>Blueberry</i>								
Control	20	—	4	53	40	8	0	2.62
Blueberry Juice Conc.	20	5.0	4	54	39	8	0	2.61
<i>Grape</i>								
Grape Juice Concentrate <sup>1</sup>		35.0	5	56	35	5	0	2.42
<i>Cherry</i>								
Control	20.0		6	49	40	9	0	2.66
Cherry Juice Concentrate	20.0	20.0	6	34	40	21	3	2.89**

\*Difference significant at 1% level. \*\*Difference significant at 5% level.

<sup>1</sup>The percentage is fruit equivalent as only source of flavor.

and red raspberry juice concentrate or strawberry or grape essences were used as flavor supplements.

Blueberry juice concentrate and red raspberry juice concentrate as well as grape juice concentrate when used as the only source of flavor were evaluated as very satisfactory by the professional panel.

The blueberry juice concentrate formula which contained 16% sugar in the mix, pH of 5.7 and blueberry juice concentrate used as the only source of flavor equivalent to 20% fruit produced a cooked blueberry flavor which was rated highly by the professional panel.

Although red raspberry juice concentrate did not improve the flavor of raspberry ice cream when used as a supplement, but when it was used as the only source of flavor at a rate equivalent to 10% fruit, the finished ice cream was evaluated as very satisfactory.

#### **Consumer Evaluation of Ice Cream**

The results of consumer evaluation of ice cream without flavor supplementation and ice cream supplemented with flavor concentrates selected as the best rate of supplementation by the professional panel are shown in table 1. The ice cream composition used in these products was the basic ice cream formula previously described and flavored according to the best rate of flavor supplementation as determined by the professional panel.

Since no satisfactory flavor supplementation level could be established for strawberry juice concentrate, strawberry juice essence, raspberry juice concentrate and grape essence, ice cream flavored with these products were not submitted to a consumer panel.

Consumer rating of flavor improvement resulting from the use of fruit juice concentrates and essences was not as great as that of the professional panel.

Observations by the professional judges indicated that all the supplemented flavors shown in table 1 were preferred to the control. Consumer evaluation showed a higher rating for the apple juice concentrate and cherry juice concentrate supplemented ice cream and little difference in the other supplemented flavors over the control.

#### **Storage Properties**

Results of storage studies of the ice cream made with the various fruit concentrates and essences showed that there was very little change in the properties of these products during an 8-week storage period. One control peach sample showed an oxidized flavor after the third week of storage. This defect was not observed in the peach juice concentrate or peach puree concentrate supplemented products. Little if any change was noted in alcohol stability, pH or acidity values during storage. There was little change in body and texture or color characteristics of the product studied.

#### **Cost of Fruit Juice Concentrate or Essence for Flavoring Ice Cream**

The approximate flavor cost for fruit and for fruit concentrate or essence in ice cream is shown in table 2.

The cost of flavor supplementation with fruit concentrate or essence ranged from 0.4 cents to 4.0 cents per gallon of mix. The use of fruit concentrates and essences to supplement the flavor of ice cream in the flavors observed in this investigation amounted to an average increase of approximately 6% in flavor cost.

The use of grape juice concentrate as the only source of flavoring material resulted in a flavor cost of 31 cents per gallon of mix. This compares favorably to flavoring costs which prevailed when fruit was used as the flavoring material.

## Sherbets

### Range in Rate of Supplementation and Best Formula Established by Test Mix Procedure

Results were obtained on studies using test sherbet mixes of 300 grams plus 75 grams of fruit with the same sugar content in all mixes. The test mixes consisted of a control containing 20% fruit and mixes containing various levels of fruit concentrate supplementation or fruit equivalent and various pH levels, adjusted by the addition of 50% citric acid.

**Peach Juice Concentrate:** The results of observing test sherbet mixes supplemented with 5, 10, 15, 20, 25, 30 and 35% fruit equivalent with peach juice

Table 2. Cost of fruit juice concentrate or essence for flavoring ice cream

Flavor	Amount of Fruit	Flavor suppl. fruit equiv.	Fruit concentrate amount per 5 gal. mix		Approximate flavor cost per gallon mix		
					Fruit cost	Concentrate or essence cost	Total cost
	lbs./5 gal.	%	lbs.	grams	cents	cents	cents
Peach Juice Concentrate	9.5	7.5	0.102	46.2	39.8	—	—
Peach Puree Concentrate	9.5	5.0	0.077	40.0	39.8	1.3	41.1
Apple Juice Concentrate	9.5	20.0	0.364	165.0	31.6	1.7	33.3
Apple Essence	9.5	25.0	0.016	7.2	31.6	0.40	32.0
Blueberry Juice Concentrate	9.5	5.0	0.086	39.2	25.2	4.0	29.2
Grape Juice Concentrate <sup>2</sup>	—	35.0	4.38	1986.3	—	31.0	31.0
Cherry Juice Concentrate	9.5	20.0	0.275	125.0	39.8	3.0	42.8

concentrate at the pH levels of approximately 3.6, 3.8 and 4.0 (or 0.63, 0.48 and 0.39% acid as lactic respectively) show that the mixes with the pH values of 4.0 were rated as "just right" in acidity. The mixes with pH values greater than 4.0 were evaluated as "lacking" in acidity while those mixes at the pH levels of 3.8 and 3.6 were rated as having "too much" acid. Flavor supplementation levels of 15, 20 and 25% were rated in the "just right" range while those mixes with less supplementation were evaluated as "lacking" in flavor.

The preferred formula consisted of 20% peaches supplemented with 15% fruit equivalent of peach juice concentrate and with pH adjustment to a value of 4.0.

**Peach Puree Concentrate:** Observations of test sherbet mixes supplemented with 5, 10, 15, 20, 25 and 30% fruit equivalent with peach puree concentrate at pH levels of 3.6, 3.8 (4.0 or 0.73, 0.52 and 0.42% acid as lactic respectively), show that the mixes with pH values greater than 4.0 were rated as "lacking" in acid while those with a pH value of 4.0 were preferred and the mixes with pH values of 3.6 and 3.8 were evaluated as having "too much" acid. The flavor supplementation levels of 10, 15 and 20% fruit equivalent were preferred. Peach puree concentrate used as the only source of flavoring was "lacking" in peach flavor.

The preferred formula consisted of 20% peaches supplemented with 10 to 15% fruit equivalent of peach puree concentrate with the pH adjustment to a value of 4.0.

**Apple Juice Concentrate:** When test sherbet mixes with 20% fruit at levels of 5 to 50% fruit equivalent with apple juice concentrate and various pH adjustments were observed, the preferred formula consisted of 20% apples supplemented with 30% fruit equivalent of apple juice concentrate with the pH adjustment to a value of 4.0.

**Apple Essence:** The result of examination of test sherbet mixes showed that the base mix with 20% fruit, supplemented with 35% fruit equivalent of apple essence and a pH adjustment to a value of 4.0 was preferred.

**Strawberry Juice Concentrate:** Strawberry sherbet test mixes prepared with 20% fruit, adjusted pH, supplemented with 25 to 45% fruit equivalent with strawberry juice concentrate and with strawberry juice concentrate used as the sole source of flavoring, showed the preferred formula consisted of 20% fruit supplemented with 35% fruit equivalent of strawberry juice concentrate with the pH adjusted to 3.8. Strawberry juice concentrate used at the 20% fruit equivalent level did not provide the desired flavor intensity.

**Strawberry Essence:** Results of trials conducted to establish the use of strawberry essence in flavoring sherbet failed to indicate that the essence studied could be used advantageously in flavoring sherbets.

**Blueberry Juice Concentrate:** Examination of blueberry sherbet test mixes consisting of a control, adjusted pH and supplementation with blueberry juice concentrate at the 5 to 30% levels showed that the best formula was the 20% fruit supplemented with 10 to 15% fruit equivalent of blueberry juice concentrate with the pH adjustment to pH 4.0 or (0.39% acid as lactic).

**Grape Juice Concentrate:** Trial grape sherbet mixes with adjusted pH and fruit equivalent of grape juice concentrate of 25, 30, 35 and 40% indicated that the product preferred was that with 40% fruit equivalent and pH of 3.6. A control for the grape juice concentrate or essence was not prepared as a commonly used commercial grape flavoring product is not usually available.

**Grape Essence:** Test grape sherbet mixes with adjusted acidity and fruit equivalent of 25 to 50% with grape essence as the sole source of flavor showed that the 35 to 40% fruit equivalent levels supplied by the addition of grape essence with adjusted pH of 4.0 (acidity 0.35%) were sufficient to produce the best product.

**Red Raspberry Juice Concentrate:** The results of the red raspberry test mix study showed that the formula preferred consisted of 10% fruit supplemented with 35% fruit equivalent of red raspberry concentrate and the adjustment of the pH to 4.0 (acidity 0.35%).

**Cherry Juice Concentrate:** Results of observations made on cherry sherbet test mixes consisting of a control with 20% fruit, pH adjustment from 3.4 to 3.8 and supplementation at levels of 5 to 50% fruit equivalent of cherry juice concentrate indicate that the preferred mix contained 20% fruit supplemented at the 35% fruit equivalent level with cherry juice concentrate with pH adjustment to 3.8 (0.55% acid as lactic).

#### **Flavor Supplementation Levels for Sherbets Chosen by Professional Panel**

The best levels of flavor supplementation for the concentrated fruit juices and essences in sherbets as established by the professional panel were as follows:

**Peach Juice Concentrate or Peach Puree Concentrate:** The best formula consisted of 4 gallons of basic sherbet mix, 1 gallon of ripe peaches, pH adjustment of 4.0 and a supplementation of 15% of full flavored peach juice concentrate or peach puree concentrate.

**Apple Juice Concentrate:** The preferred formula consisted of 20% fruit in the basic mix, supplemented with 30% fruit equivalent of apple juice concentrate and pH adjustment to a value of 4.0.

**Apple Essence:** The base mix with 20% fruit, supplemented with 35% fruit equivalent of apple essence and pH adjustment of the mix to 4.0 was preferred.

**Strawberry Juice Concentrate:** The preferred formula consisted of 20% fruit in the basic mix, supplemented with 35% fruit equivalent of strawberry juice concentrate and pH adjustment of the mix to 3.8.

**Strawberry Essence:** No satisfactory flavor supplementation level could be established.

**Blueberry Juice Concentrate:** The best formula consisted of 20% fruit in the basic mix, supplemented with 15% fruit equivalent of blueberry juice concentrate and with a pH adjustment of the mix to 4.0.

**Grape Juice Concentrate:** The product preferred was that with grape juice concentrate equivalent to 40% fruit as the only source of flavoring and pH adjustment to 3.6.

**Grape Essence:** The sherbet mix adjusted to pH of 4.0 and flavored with grape

essence as the only source of flavor at the rate equivalent to 35% fruit produced the best product.

**Red Raspberry Juice Concentrate:** The formula preferred consisted 10% fruit, supplemented with 35% fruit equivalent of red raspberry concentrate with pH adjusted to 4.0.

**Cherry Juice Concentrate:** The preferred mix contained 20% fruit supplemented at the 35% fruit equivalent level with cherry juice concentrate with pH adjustment to 3.8.

Results of observations by the professional panel indicated that improved flavored sherbets could be produced by the use of peach puree and peach juice concentrate, apple juice concentrate and apple essence, strawberry juice concentrate, blueberry juice concentrate, grape juice concentrate and essence, red raspberry juice concentrate and cherry juice concentrate.

The level of flavor supplementation expressed as percentage fruit equivalent was higher in all cases for sherbets than for ice cream. It was also possible to obtain greater flavor intensity in sherbets than in ice cream by using fruit juice concentrate as flavor supplementation.

Strawberry essence failed to produce improved flavor in sherbets.

### **Consumer Evaluation of Sherbets**

The results of consumer evaluation of sherbets without flavor supplementation and sherbets selected as the best rate of supplementation by the professional panel are shown in table 3. The sherbet composition and preparation used in these products was the basic sherbet formula previously described and flavored according to the best rate of flavor supplementation as determined by the professional panel.

No satisfactory flavor supplementation level could be established for strawberry essence. Sherbet flavored with this product was not submitted to a consumer panel.

An analysis of variance shows that the consumer rating resulted in a difference between the control and flavor supplemented sherbet significant at the 1% level for sherbets with flavor supplementation with peach puree concentrate, apple juice concentrate, apple essence, strawberry juice concentrate, blueberry juice concentrate and red raspberry juice concentrate.

The sherbets flavored with grape juice concentrate or grape essences showed a consumer rating mean value of "just right." The consumer rating of all sherbets with flavor supplementation with fruit concentrates or essences showed mean values of "very slightly lacking" to "just right."

The sherbets with flavor supplementation with peach juice concentrate and cherry juice concentrate were the only sherbet products selected as best by the professional panel which did not receive a similar rating by the consumer panel.

### **Storage Studies of Sherbets**

The flavor and body and texture observations made each week by the judging panel on pint samples of sherbets subjected to storage at 10° F. showed

Table 3. Consumer evaluation of control and flavor supplemented sherbet

Table 3. Consumer evaluation of control and flavo- and fruit concentrates									
Flavor	Amount of Fruit %	Flavor Suppl. Equiv. %	Consumer rating					Mean value	
			(1)	(2)	(3)	(4)	(5)		
			Completely lacking	Somewhat lacking	Just right	Somewhat too much	Much too much		
Number of consumers									
<i>Peach</i>									
Control	20	—	9	29	48	13	1	2.68	
Peach Juice Concentrate	20	15	5	42	41	11	1	2.61	
Control	20	—	6	37	43	13	1	2.66	
Peach Puree Concentrate	20	15	2	25	53	20	0	2.96*	
<i>Apple</i>									
Control	20	—	10	59	24	15	0	2.41	
Apple Juice Concentrate	20	30	1	33	61	13	0	2.80*	
Control	20	—	8	61	33	6	2	2.39	
Apple Essence	20	35	1	22	68	17	2	2.97*	
<i>Strawberry</i>									
Control	20	—	3	35	49	13	2	2.76	
Strawberry Juice Concentrate	20	35	0	16	45	39	2	3.06*	
<i>Blueberry</i>									
Control	20	—	5	55	32	11	0	2.48	
Blueberry Juice Concentrate	20	15	3	27	58	14	1	2.83*	

<i>Grape</i>									
Grape Juice Concentrate <sup>1</sup>	—	40	2	35	42	21	0	2.82	
Grape Essence <sup>1</sup>	—	55	0	34	58	9	0	2.76	
<i>Red Raspberry</i>									
Control	10	—	13	53	34	9	1	2.38	
Red Raspberry Juice Conc.	10	30	4	31	66	9	0	2.72*	
<i>Cherry</i>									
Control	20	—	9	63	35	5	1	2.35	
Cherry Juice Concentrate	20	40	11	33	52	15	2	2.68*	

\*Significant at 1% level. \*\*Significant at 5% level.  
<sup>1</sup>The percentage is fruit equivalent as only source of flavor.

that in general there was little deterioration except that in some random cases an oxidized or storage flavor was detected at the end of the sixth or seventh week. None of these defects could be associated with any flavoring products.

Acidity or pH determinations made on the sherbets each week during storage indicated that there was little change in these values during the 8-week storage period.

#### **Cost of Fruit Juice Concentrate or Essence for Flavoring Sherbets**

The approximate flavor cost for fruit and for fruit concentrate or essence in sherbet is shown in table 4.

The cost of flavor supplementation with fruit concentrates or essences to flavor sherbet ranged from 0.5 cents to 12.8 cents per gallon of mix. The use of fruit concentrates and essences to supplement the flavor of sherbet in the flavors observed in this investigation amounted to an average increase in flavor cost of approximately 15%. Grape juice concentrate and grape essence used as the only source of flavor proved favorable from a cost standpoint.

**Table 4. Cost of fruit juice concentrate or essence for flavoring sherbets**

<i>Flavor</i>	<i>Amount of Fruit</i>	<i>Flavor suppl. fruit equiv.</i>	<i>Fruit concentrate amount per 5 gal. mix</i>		<i>Approximate flavor cost per gallon mix</i>		
					<i>Fruit cost</i>	<i>Concentrate or essence cost</i>	<i>Total cost</i>
	<i>lbs./5 gal.</i>	<i>%</i>	<i>lbs.</i>	<i>grams</i>	<i>cents</i>	<i>cents</i>	<i>cents</i>
Peach Juice Concentrate	9.50	15	0.2714	123.2	39.8	—	—
Peach Puree Concentrate	9.50	15	0.2298	104.3	39.8	3.7	43.5
Apple Juice Concentrate	9.50	30	0.5188	235.4	31.6	2.4	34.0
Apple Essence	9.50	35	0.0195	10.0	31.6	0.5	32.1
Strawberry Juice Concentrate	9.50	35	0.4667	211.9	64.5	12.2	76.7
Blueberry Juice Concentrate	9.50	15	0.2591	117.6	25.2	12.8	38.0
Grape Juice Concentrate <sup>2</sup>	—	40	6.000	2724.0	—	42.5	42.5
Grape Essence <sup>2</sup>	—	35	0.1930	87.3	—	4.6	4.6
Red Raspberry Juice Conc.	4.75	35	0.2481	112.6	32.4	7.0	39.4
Cherry Juice Concentrate	9.50	35	0.4814	218.6	39.8	3.1	42.9

<sup>1</sup>Cost not available.

<sup>2</sup>Percentage is fruit equivalent as only source of flavor.

Table 5. Consumer evaluation of control and flavor supplemented ices

Flavor	Amount of Fruit %	Flavor Suppl. Fruit Equiv. %	Consumer rating					Mean value	
			(1) Completely lacking	(2) Somewhat lacking	(3) Just right	(4) Somewhat too much	(5) Much too much		
			Number of consumers						
<i>Peach</i>									
Control	20	—	20	55	25	9	1	2.24	
Peach Juice Concentrate	20	30	11	50	29	16	4	2.56*	
Control	20	—	16	53	35	6	0	2.28	
Peach Puree Concentrate	20	30	2	52	38	16	2	2.67*	
<i>Strawberry</i>									
Control	20	—	15	48	37	10	0	2.38	
Strawberry Juice Concentrate	20	30	4	38	49	18	1	2.76*	
<i>Blueberry</i>									
Control	20	—	5	51	36	15	3	2.64	
Blueberry Juice Concentrate	20	10	4	42	48	14	2	2.71	
<i>Grape</i>									
Grape Juice Concentrate <sup>1</sup>	20	35	0	39	60	11	3	2.81	
<i>Red Raspberry</i>									
Control	10	—	10	62	30	7	1	2.34	
Red Raspberry Juice Conc.	10	10	1	16	70	23	0	3.05*	
<i>Cherry</i>									
Control	20	—	13	51	38	7	2	2.41	
Cherry Juice Concentrate	20	35	8	35	46	17	5	2.78*	

\*Significant at 1% level.

<sup>1</sup>The percentage is fruit equivalent as only source of flavor.

## Ices

### Range in Rate of Supplementation and Best Formulas Established by Test Mix Procedures

The test mix procedure previously described was used to establish use levels of the different fruit juice concentrates and essences for ices.

The test mixes consisted of a control ice mix of basic composition containing 20% fruit, and mixes containing various levels of fruit concentrate supplementations or fruit equivalent, and various pH levels, adjusted by the addition of 50% citric acid.

It was found that the range in flavor levels established for sherbets were also quite applicable for ices. Approximately the same range in flavor was used in ices as for sherbets for establishing the best flavor level for each flavor of ice by the professional panel.

### Flavor Supplementation Levels for Ices

#### Chosen by Professional Panel

The best levels of flavor supplementation for the concentrated fruit juices and essences in ices as established by the professional panel using the basic ice

Table 6. Cost of fruit juice concentrate or essence for flavoring ices

Flavor	Amount of Fruit	Flavor suppl. fruit equiv.	Fruit concentrate amount per 5 gal. mix		Approximate flavor cost per gallon mix		
			lbs.	grams	Fruit cost cents	Concentrate or essence cost cents	Total cost cents
	lbs./5 gal.	%					
Peach Juice Concentrate	9.50	30	0.4286	194.6	39.8	<sup>1</sup> —	—
Peach Puree Concentrate	9.50	30	0.4839	219.7	39.8	7.8	46.6
Strawberry Juice Concentrate	9.50	30	0.4000	181.6	64.5	10.5	75.0
Blueberry Juice Concentrate	9.50	10	0.1818	82.54	25.2	9.0	34.2
Grape Juice Concentrate <sup>2</sup>	—	35	5.2500	2283.5	—	37.2	37.2
Red Raspberry Juice Conc.	4.75	10	0.1493	67.8	32.4	4.2	36.6
Cherry Juice Concentrate	9.50	35	0.5072	230.3	39.8	3.3	43.1

<sup>1</sup>Price not available.

<sup>2</sup>Percentage is fruit equivalent as only source of flavor.

formula previously described were as follows:

**Peach Juice Concentrate or Peach Puree Concentrate:** The preferred formula consisted of 20% fruit in the basic mix supplemented with 30% fruit equivalent of peach juice concentrate or peach puree concentrate and pH adjustment to 3.2.

**Apple Juice Concentrate or Apple Essence:** No satisfactory flavor supplementation level could be established for ices.

**Strawberry Juice Concentrate:** The preferred formula consisted of 20% fruit in the basic mix supplemented with 30% fruit equivalent of strawberry juice concentrate and pH adjustment to pH 3.0.

**Strawberry Essence:** No satisfactory flavor supplementation level could be established.

**Blueberry Juice Concentrate:** The best formula consisted of 20% fruit in the basic mix with 10% fruit equivalent of blueberry juice concentrate and with a pH adjustment of the mix to 3.0.

**Grape Juice Concentrate:** The product preferred was that with 35% fruit equivalent of grape juice concentrate as the only source of flavoring and pH adjustment of 3.2.

**Grape Essence:** No satisfactory flavor supplementation level could be established.

**Red Raspberry Juice Concentrate:** The formula preferred consisted of 10% fruit supplemented with 10% fruit equivalent of red raspberry juice concentrate and pH adjustment of 3.0.

**Cherry Juice Concentrate:** The preferred mix contained 20% fruit supplemented with 35% fruit equivalent of cherry juice concentrate and pH adjustment of 3.0.

Results of observations by the professional panel indicate that fruit concentrate could be used to produce improved flavors in all products except when apple juice concentrate, apple essence, strawberry essence and grape essence were used.

The level of fruit supplementation was somewhat higher for most flavors of ices than for sherbets. The desired flavor intensity occurred at a lower pH value.

### **Consumer Evaluation of Ices**

The results of consumer evaluation of ices without flavor supplementation and ices selected as the best by professional panel are shown in table 5.

No satisfactory flavor supplementation level could be established for apple juice concentrate or apple essence, strawberry essence and grape essence. Ices flavored with these products were not submitted to a consumer panel.

The analysis of variance showed that the consumer rating resulted in a difference between the control and flavor supplemented ices significant at the 1% level for all flavors established as best by the professional panel—except for the blueberry ice supplemented with blueberry juice concentrate. Consumer acceptance seemed to be very favorable to the use of concentrates and essences in ices.

The consumer rating of all ices with flavor supplementation with fruit concentrates showed mean values of “very slightly lacking” to “just right.”

The evaluation by the consumer panel indicated a greater difference between the control and the supplemented products for raspberry juice concentrate and cherry juice concentrate. The grape juice concentrate supplemented product rated near the "just right" range. There was less difference between the control and supplemented product for the peach juice concentrate, peach puree concentrate and strawberry juice concentrate. An analysis of variance indicated that the consumer rating was significant at the 1% level for all flavors of ices studied—except for blueberry. Little difference was noted by the consumer panel in the sherbet supplemented with blueberry juice concentrate and the control.

#### **Storage Studies of Ices**

The flavor, body and texture and overall observations made each week by the professional panel on pint samples of ices stored at 10° F. showed that there was little change which could be attributed to any flavoring product. There was a greater predominance of a slightly coarse body and texture defect after the storage period and slight storage flavor was observed during the storage period.

Acidity or pH determination made on the ices each week during the storage period indicated there was little change in these values during the 8-week storage period.

#### **Cost of Fruit Juice Concentrate or Essence for Flavoring Ices**

The approximate flavor cost for fruit and for fruit concentrate or essence in ice is shown in table 6.

The cost of flavor supplementation with fruit concentrate for ice ranged from 3.3 cents to 10.5 cents per gallon of mix. The use of fruit concentrates to supplement the flavor of ices in the flavors observed in this study amounted to an average increase of approximately 18% in flavor cost.

The use of grape juice concentrate as the only source of flavoring material for grape ice resulted in a flavor cost of about 36.6 cents per gallon of mix.

### **Ice Milk**

#### **Range in Rate of Supplementation and Best Formulas Established by Test Mix Procedures**

The test mix procedure previously described for ice cream and the approximate rate of flavor supplementation used for ice cream was used to establish the levels of supplementation of the different fruit concentrates and essences for ice milk.

It was found that the range in flavor levels as for sherbets and pH adjustment established for ice cream were also applicable for ice milk. Approximately the same range in flavor was used in ice milk as for sherbets in establishing the best flavor level for each flavor of ice milk. The basic ice milk formula previously presented was used for all ice milk studied.

### **Chosen by Professional Panel**

The best levels of flavor supplementation for the concentrated fruit juices and essences in ice milk as established by the professional panel were as follows:

**Peach Juice Concentrate:** The preferred formula consisted of 20% fruit in the basic mix, supplemented with 45% fruit equivalent of peach juice concentrate and pH of mix 5.7.

**Peach Puree Concentrate:** The preferred formula consisted of 20% fruit in the basic mix, supplemented with 20% fruit equivalent of peach puree concentrate, with pH of mix 5.6.

**Apple Juice Concentrate:** The best formula consisted of 20% fruit in the basic mix, with 45% fruit equivalent of apple juice concentrate, with pH not adjusted at 6.2.

**Apple Essence:** The formula preferred consisted of 20% fruit in the basic mix, with 45% fruit equivalent of apple essence, with pH of 6.2, which was not adjusted.

**Strawberry Juice Concentrate:** The preferred formula consisted of 20% fruit in the basic mix supplemented, with 20% fruit equivalent of strawberry juice concentrate and pH not adjusted at 6.2.

**Strawberry Essence:** No satisfactory formula could be established for ice milk using strawberry essence.

**Blueberry Juice Concentrate:** The preferred formula consisted of the basic mix, supplemented with 15% fruit equivalent of blueberry juice concentrate, with pH adjusted to 5.7.

**Grape Juice Concentrate:** The preferred formula consisted of the basic milk, supplemented with 40% fruit equivalent of grape juice concentrate, with pH not adjusted.

**Grape Essence:** The best formula consisted of the basic mix, supplemented with 55% fruit equivalent of grape essence, with pH not adjusted.

**Red Raspberry Juice Concentrate:** The preferred formula consisted of 10% fruit in the basic mix, supplemented with 30% fruit equivalent of red raspberry juice concentrate, with pH not adjusted.

**Cherry Juice Concentrate:** The preferred formula consisted of the basic mix, supplemented with 40% fruit equivalent of cherry juice concentrate, with pH adjusted to 5.4.

Results of observations by the professional panel indicated that improved flavored ice milk could be produced by the use of peach juice concentrate, peach puree concentrate, apple juice concentrate, apple essence, strawberry juice concentrate, blueberry juice concentrate, grape juice concentrate, grape essence, red raspberry juice concentrate and cherry juice concentrate.

The amount of concentrate or essence necessary to produce the preferred formula was greater for ice milk than for ice cream, sherbets or ices. This is apparently due to the relatively higher milk solids-not-fat content of the basic ice milk formula used in the investigation.

Table 7. Consumer evaluation of control and flavor supplemented ice milk

Flavor	Amount of Fruit %	Flavor Suppl. Fruit Equiv. %	Consumer rating					Mean value	
			(1) Completely lacking	(2) Somewhat lacking	(3) Just right	(4) Somewhat too much	(5) Much too much		
			Number of consumers						
<i>Peach</i>									
Control	20	—	23	63	23	1	0	2.02	
Peach Juice Concentrate	20	45	21	51	32	2	4	2.24**	
Control	20	—	20	59	29	1	1	2.13	
Peach Puree Concentrate	20	25	17	60	28	3	2	2.21	
<i>Apple</i>									
Control	20	—	17	57	24	11	1	2.29	
Apple Juice Concentrate	20	45	6	45	47	12	0	2.59*	
Control	20	—	12	50	42	5	1	2.39	
Apple Essence	20	45	6	39	59	6	0	2.59**	
<i>Strawberry</i>									
Control	20	—	5	47	41	12	2	2.62	
Strawberry Juice Concentrate	20	25	6	39	52	8	1	2.61	
<i>Blueberry</i>									
Control	20	—	6	55	42	9	1	2.50	
Blueberry Juice Concentrate	20	15	1	39	61	12	0	2.74*	



## Consumer Evaluation of Ice Milk

The results of consumer evaluation of the control and flavor-supplemented ice milk are shown in table 7. The ice milk composition and fruit preparation used in these products was the basic ice milk formula, flavored according to the best rate of flavor supplementation as determined by the professional panel.

The analysis of variance showed that the consumer rating resulted in a difference between the control and flavor supplemented ice milk significant at the 1% level for products supplemented with apple juice concentrate, apple essence, blueberry juice concentrate and cherry juice concentrate.

The ice milk flavored with grape juice concentrate and grape juice essence showed a consumer rating mean value of "slightly lacking." The consumer rating of all ice milk with flavor supplementation showed mean values of

Table 8. Cost of fruit juice concentrate or essence for flavoring ice milk

Flavor	Amount of Fruit	Flavor suppl. fruit equiv.	Fruit concentrate amount per 5 gal. mix		Approximate flavor cost per gallon mix		
					Fruit cost	Concentrate or essence cost	Total cost
	lbs./5 gal.	%	lbs.	grams	cents	cents	cents
Peach Juice Concentrate	9.5	45	0.6107	277.3	39.8	<sup>1</sup> —	—
Peach Puree Concentrate	9.5	25	0.3831	173.9	39.8	6.2	46.0
Apple Juice Concentrate	9.5	45	0.8182	371.4	31.6	3.7	35.3
Apple Essence	9.5	45	0.325	12.9	31.6	0.7	32.3
Strawberry Juice Concentrate	9.5	25	0.333	151.3	64.5	8.6	73.1
Blueberry Juice Concentrate	9.5	15	0.2591	117.6	25.2	12.9	38.1
Grape Juice Concentrate <sup>2</sup>	—	45	6.000	2724.0	—	42.5	42.5
Grape Essence <sup>2</sup>	—	55	0.303	137.1	—	8.3	8.3
Red Raspberry Juice Conc.	9.5	30	0.2127	96.6	32.4	6.2	38.6
Cherry Juice Concentrate	9.5	40	0.5797	263.2	39.8	3.7	43.5

<sup>1</sup>Price not available.

<sup>2</sup>The percentage is fruit equivalent as only source of flavor.

Table 9. Consumer evaluation of control and flavor supplemented variegated ice cream

Flavor	Amount of fruit base sirup %	Flavor Suppl. Fruit Equiv. %	Consumer rating					Mean value
			(1) Completely lacking	(2) Somewhat lacking	(3) Just right	(4) Somewhat too much	(5) Much too much	
			Number of consumers					
<i>Strawberry</i>								
Control	20	—	2	47	44	11	3	2.31
Strawberry Juice Concentrate	20	30	1	36	52	18	0	2.35
<i>Blueberry</i>								
Control	20	—	4	50	40	14	2	2.64
Blueberry Juice Concentrate	20	20	5	43	50	12	0	2.63
<i>Red Raspberry</i>								
Control	20	—	3	57	40	8	2	2.54
Red Raspberry Juice Conc.	20	10	0	25	68	16	1	2.94*
<i>Cherry</i>								
Control	20	—	8	50	50	3	1	2.50
Cherry Juice Concentrate	20	40	19	54	27	18	5	2.77*

\*Significant at 1% level.

"slightly lacking" in flavor. These ratings were somewhat lower than those for sherbets and ices.

The ice milk supplemented with peach juice concentrate, peach puree concentrate and strawberry juice concentrate selected as best by the professional panel along with their controls failed to receive favorable acceptance from the consumer panel.

#### **Storage Studies of Ice Milk**

The flavor, body and texture observations made each week by the judging panel gave similar results to those for the other products previously described. There were no storage defects which could be associated with any of the flavor supplementation materials. There were not extensive changes in acidity, pH or protein stability during the storage period.

#### **Cost of Fruit Juice Concentrate or Essence for Flavoring Ice Milk**

The approximate flavor cost for fruit and for fruit concentrate or essence in ice milk is shown in table 8.

The cost of flavor supplementation with fruit concentrate or essence for ice milk ranged from 0.7 cents to about 13 cents per gallon of mix. The use of fruit concentrates and essences to supplement the flavor of ice milk in the flavors observed increased the flavor cost about 13%.

Grape juice concentrate and grape essence used as the only source of flavor in grape ice milk resulted in a favorable cost per gallon of mix. The use of grape essence seemed to be much more economical than grape juice concentrate.

### **Variegated Ice Cream**

#### **Range in Rate of Supplementation and Best Formulas Established for Variegated Ice Cream**

Results were obtained using test portions of the base fruit sirup. The base fruit sirup prepared as previously described supplemented at levels similar to those used for sherbets and ices were observed in order to establish the flavor supplementation range. Ice cream of the basic composition used in this investigation with base fruit sirup supplemented to at least three levels injected in the ice cream at the rate of 20% of the ice cream mix resulted in the following best formulas chosen by the professional panel.

#### **Flavor Supplementation Levels for Variegated Ice Cream Chosen by the Professional Panel**

The best levels of supplementation of the base fruit sirup for variegated ice cream as established by the professional panel were as follows:

**Peach Juice Concentrate:** The preferred formula consisted of 20% fruit base

sirup injected in the ice cream mix. An additional amount of fruit was used in the fruit base sirup for peach variegated ice cream to make a rate of 43 pounds fruit per 100 pounds of sirup. This sirup was supplemented with 40% fruit equivalent of peach juice concentrate. This formula was not presented to the consumer panel since it did not receive predominant agreement from the professional panel. No satisfactory formula could be established.

**Peach Puree Concentrate:** The formula chosen as best consisted of 20% fruit base sirup injected in the ice cream mix. An additional amount of fruit was used in the fruit base sirup for peach variegated ice cream to make a rate of 43 pounds fruit per 100 pounds of sirup. This sirup was supplemented with 30% fruit equivalent of peach puree concentrate. This formula was not presented to the consumer panel since it did not receive predominant agreement from the professional panel. No satisfactory formula could be established.

**Apple Juice Concentrate:** No satisfactory flavor supplementation level could be established.

**Apple Essence:** No satisfactory flavor supplementation level could be established.

**Strawberry Juice Concentrate:** The preferred formula consisted of 20% fruit base sirup injected in the ice cream. The percentage was based on the amount of mix. The sirup was supplemented with 30% fruit equivalent of strawberry juice concentrate.

**Strawberry Essence Concentrate:** No satisfactory supplementation level could be established.

**Blueberry Juice Concentrate:** The formula chosen as best consisted of 20% fruit base sirup injected on a mix basis in the ice cream. The sirup was supplemented with 20% fruit equivalent of blueberry juice concentrate.

**Grape Juice Concentrate:** No satisfactory supplementation level could be established.

**Grape Essence:** No satisfactory supplementation level could be established.

**Red Raspberry Juice Concentrate:** The preferred formula consisted of 20% fruit base sirup injected on mix basis in the ice cream. This sirup was supplemented with 10% fruit equivalent of red raspberry juice concentrate.

**Cherry Juice Concentrate:** The formula chosen consisted of 20% fruit base sirup injected on a mix basis in the ice cream. The sirup was supplemented with 40% fruit equivalent of cherry juice concentrate.

### **Consumer Evaluation of Variegated Ice Cream**

The results of consumer evaluation of variegated ice cream with and without flavor supplementation are shown in table 9.

### **Storage Studies of Variegated Ice Cream**

The observations made by a panel of judges on the variegated ice cream during storage indicated that there was little change in the quality of the product during the storage period. No change during storage could be attributed to the fruit concentrate or essence used. Also there was little change in the acidity, pH or protein stability during the storage period.

# **Cost of Fruit Juice Concentrate or Essence for Flavoring Variegated Ice Cream**

The approximate cost of fruit and of fruit concentrates or essences in variegated ice cream is shown in table 10.

The cost of flavor supplementation with concentrates or essences for variegated ice cream ranged from 3.1 cents to 14.8 cents per gallon of ice cream mix. The use of grape juice concentrate as the only source of flavor amounted to 43 cents per gallon of mix. The use of concentrates and essences in variegated ice cream increased the flavor cost about 40%.

**Table 10. Cost of fruit juice concentrate or essence for flavoring variegated ice cream**

Flavor	Approximate flavor cost per gallon mix						
	Amount of Fruit	Flavor suppl. fruit equiv.	Fruit concentrate amount per 5 gal. mix		Fruit cost	Concentrate or essence cost	Total cost
			lbs.	grams			
Peach Juice Concentrate	4.1	40	0.4714	214.0	17.2	<sup>1</sup> —	—
Peach Puree Concentrate	4.1	30	0.3992	181.2	17.2	6.4	23.6
Strawberry Juice Concentrate	3.2	30	0.330	149.8	21.7	8.6	30.3
Blueberry Juice Concentrate	3.2	20	0.300	136.2	18.0	14.8	32.8
Grape Juice Concentrate <sup>2</sup>	—	45	6.1	2769.4	—	43.0	43.0
Red Raspberry Juice Conc.	1.6	10	0.1231	55.9	10.9	3.4	14.3
Cherry Juice Concentrate	3.2	40	0.4783	217.1	13.4	3.1	16.5

<sup>1</sup>Price is not available.

<sup>2</sup>Percentage is fruit equivalent as only source of flavor.

## **DISCUSSION OF DATA ON BEST FORMULAS SELECTED BY PROFESSIONAL PANEL AND CONSUMER EVALUATION OF BEST FORMULAS**

The professional panel selected 41 preferred formulas in which fruit concentrates or essences were used. Twenty-seven of these formulas also received favorable acceptance by the consumer panel. Those formulas which were preferred by the professional panel and received favorable consumer rating by the consumer panel were as follows:

**Apple Juice Concentrate in Ice Cream:** The preferred formula contained 15% sugar in the basic ice cream mix with pH adjusted to 6.2 with 20% fruit equivalent supplementation of apple juice concentrate. The cost of the apple juice concentrate supplementation in this product was 1.7 cents per gallon of ice cream mix.

**Cherry Juice Concentrate in Ice Cream:** The preferred formula contained 15% sugar in the basic ice cream mix, with pH of 5.2 and 20% fruit, supplemented with 15% fruit equivalent of cherry juice concentrate. The cost of the cherry juice concentrate supplementation in this product was 3 cents per gallon of ice cream mix.

**Peach Puree Concentrate in Sherbet:** The best formula consisted of 4 gallons of basic sherbet mix, 1 gallon peaches, mix adjusted to pH 4.0 and supplementation of 15% fruit equivalent of peach puree concentrate. The cost of peach puree concentrate supplementation in this product was 3.7 cents per gallon of sherbet mix.

**Apple Juice Concentrate in Sherbet:** The preferred formula consisted of 20% fruit in the basic mix, supplemented with 30% fruit equivalent of apple juice concentrate and pH adjustment to a value of 2.4. The cost of apple juice supplementation in this product was 2.8 cents per gallon of sherbet mix.

**Apple Essence in Sherbet:** The preferred sherbet mix contained 20% fruit, supplemented with 35% fruit equivalent of apple essence and pH adjustment of the mix to 4.0. The cost of apple essence supplementation in this product was 0.5 cents per gallon of sherbet mix.

**Strawberry Juice Concentrate in Sherbet:** The preferred formula consisted of 20% fruit in the basic sherbet mix, supplemented with 35% fruit equivalent of strawberry juice concentrate, with mix adjustment to pH 3.8. The cost of strawberry juice concentrate supplementation in this mix was 12.2 cents per gallon of sherbet mix.

**Blueberry Juice Concentrate in Sherbet:** This formula consisted of 20% fruit equivalent of blueberry juice concentrate, with a pH adjustment of the mix to 4.0. The cost of the blueberry juice concentrate supplementation was 12.8 cents per gallon of sherbet mix.

**Grape Juice Concentrate in Sherbet:** This product contained grape juice concentrate in the basic sherbet mix equivalent to 40% fruit as the only source of flavoring. The pH of the mix was adjusted to 3.6. The total cost of flavoring

this mix with grape juice concentrate was 42.5 cents per gallon of sherbet mix.  
**Grape Essence in Sherbet:** The preferred formula was the basic sherbet mix, adjusted to pH of 4.0 and flavored at the rate equivalent to 35% fruit equivalent. The total cost of flavoring with grape essence was 4.6 cents per gallon of sherbet mix.

**Red Raspberry Juice Concentrate in Sherbet:** The preferred formula consisted of 10% fruit in the basic sherbet mix, supplemented with 35% fruit equivalent of red raspberry concentrate, with the mix adjusted to pH 4.0. The cost of flavor supplementation was 7 cents per gallon of sherbet mix.

**Cherry Juice Concentrate in Sherbet:** The preferred formula consisted of 20% fruit, supplemented at the 35% fruit equivalent level with cherry juice concentrate, with pH adjusted to 3.8. The cost of the cherry juice concentrate in this product was 3.1 cents per gallon of sherbet mix.

**Peach Juice Concentrate in Ice:** The preferred formula consisted of 20% fruit in the basic ice mix, supplemented with 30% fruit equivalent of peach juice concentrate, with pH adjustment of the mix to 3.2. No price is available.

**Peach Puree Concentrate in Ice:** The preferred formula consisted of 20% fruit in the basic ice mix, supplemented with 30% fruit equivalent of peach puree concentrate, with mix adjustment to pH 3.2. The cost of flavor supplementation with peach puree concentrate was 7.8 cents per gallon of ice mix.

**Strawberry Juice Concentrate in Ice:** This formula consisted of 20% fruit in the basic ice mix, supplemented with 30% fruit equivalent of strawberry juice concentrate, with pH adjustment of the mix to 3.0. The cost per gallon of ice mix for flavor supplementation was 10.5 cents.

**Grape Juice Concentrate in Ice:** This product contained 35% fruit equivalent of grape juice concentrate in the basic ice mix as the only source of flavoring. The mix was adjusted to pH 3.2. The flavor cost was 37.2 cents per gallon of ice mix.

**Red Raspberry Juice Concentrate in Ice:** The formula was 10% fruit in the basic ice mix, supplemented with 10% fruit equivalent of red raspberry juice concentrate, with pH adjusted to 3.0. The supplementation cost was 4.2 cents per gallon of ice mix.

**Cherry Juice Concentrate in Ice:** The preferred mix contained 20% fruit in the basic ice mix, supplemented with 35% fruit equivalent of cherry juice concentrate, with pH adjusted to 3.0. The flavor supplementation cost was 3.3 cents per gallon of ice mix.

**Peach Juice Concentrate in Ice Milk:** The preferred formula consisted of 20% fruit in the basic mix, supplemented with 45% fruit equivalent of peach juice concentrate, with pH of 5.7. Cost figures are not available.

**Apple Juice Concentrate in Ice Milk:** The preferred formula consisted of 20% fruit in the basic ice milk mix, supplemented with 45% fruit equivalent of apple juice concentrate, with a pH of 6.2. The cost of flavor supplementation was 3.7 cents per gallon of ice milk mix.

**Apple Essence in Ice Milk:** The best formula consisted of 20% fruit in the basic mix, supplemented with 45% fruit equivalent of apple essence, with pH of 6.2 which was not adjusted. The price of supplementation was 0.7 cents per gallon of mix.

**Blueberry Juice Concentrate in Ice Milk:** The formula consisted of the basic ice milk mix, with 20% fruit supplemented with 15% fruit equivalent of blueberry juice concentrate. The pH of the mix was adjusted to 5.7. The supplementation cost was 12.9 per gallon of mix.

**Grape Juice Concentrate in Ice Milk:** The formula consisted of the basic ice milk mix, supplemented with 40% fruit equivalent with grape juice concentrate as the only source of flavor. The pH was not adjusted. The cost of flavoring ice milk with grape juice concentrate was 42.5 cents per gallon of mix.

**Grape Essence in Ice Milk:** The best formula consisted of basic mix, supplemented with 55% of grape essence as the only source of flavor, with pH not adjusted. The cost was 8.3 cents per gallon of mix.

**Red Raspberry Juice Concentrate in Ice Milk:** The preferred formula consisted of 10% fruit in the basic mix, supplemented with 30% fruit equivalent of red raspberry juice concentrate, with pH not adjusted. The cost was 6.2 cents per gallon.

**Cherry Juice Concentrate in Ice Milk:** The preferred formula consisted of the basic ice milk mix, with 20% fruit supplemented with 40% fruit equivalent of cherry juice concentrate. The pH was adjusted to 5.2. The flavor cost of the cherry juice concentrate supplementation amounted to 3.7 cents per gallon of mix.

**Red Raspberry Juice Concentrate in Variegated Ice Cream:** This formula consisted of 20% fruit base sirup injected on a mix basis in the ice cream. The sirup was supplemented with 10% fruit equivalent of raspberry juice concentrate. The cost was 3.4 cents per gallon of mix.

**Cherry Juice Concentrate in Variegated Ice Cream:** The preferred formula consisted of 20% fruit base sirup injected on a mix basis in the ice cream. The sirup was supplemented with 40% fruit equivalent of cherry juice concentrate. The cost was 3.1 cents per gallon of mix.

## GENERAL DISCUSSION AND CONCLUSIONS

The results presented in this publication are those of a study on the technology of utilizing concentrated fruit juices and essences in ice cream and related products. The concentrates or essences of seven different fruits including peach, apple, strawberry, blueberry, grape, red raspberry and cherry were studied as flavoring materials for ice cream, sherbets, ices, ice milk and variegated ice cream.

It was necessary to conduct extensive and prolonged preliminary investigations to establish the effect of sugar content of the mix, pH adjustment and other factors which were necessary to give optimum flavor results for each fruit before the procedure set forth in the project could be attempted.

A laboratory procedure was developed which made possible the rapid flavor observation of hundreds of flavor supplementation levels, different sugar levels and various pH adjustments for the products studied.

Mix formulas were established for each product studied. These formulas were developed on the basis of obtaining a formula which would produce a high quality product and which would have full commercial application in the ice cream industry.

The results of the numerous observations made by the aid of the laboratory procedure indicated that the sugar content of the mix and the pH adjustment were factors of importance which affected the flavor produced by the addition of fruit concentrates and essences. These findings provided information used in establishing the best formulas for the different products and in determining the best use levels of the different fruit concentrates.

The professional panel of judges observed more than 3,000 test mix formulas in establishing basic mix composition and range in flavor supplementation for the various products and various fruit concentrates and essences. Over 500 samples of frozen products of different composition, percentage overrun, acidity adjustment and levels of flavor supplementation were observed by the professional panel in establishing the 41 best formulas. The formulas selected as best for the different products by the professional panel when submitted to the consumer panel for rating resulted in over 8,000 observations.

The analysis of variance and mean values of consumer ratings indicated that over half of the formula selected by the professional panel also received favorable acceptance by the consumer panel.

It would seem that the use of fruit concentrates and essences as shown in the 41 best formulas selected by the professional panel could be recommended for producing a finished product with an improved flavor. It appeared that the professional panel recognized the delicate natural fruit flavor more readily than the consumer panel. Indications were that many consumers expected a pronounced imitation flavor when rating a product as having too much flavor. Since it was quite difficult to over-flavor when using natural fruit flavors, the consumer ratings usually were near the "just right" or "slightly lacking" level rather than approaching the "slightly too much" level.

It was also found that a fruit concentrate might produce a given degree of flavor intensity when a certain amount of concentrate was used, with a greater use level failing to produce a more pronounced flavor. However, there usually were no objectionable flavor characteristics resulting from the higher use levels. In some cases it was difficult to establish the use level which gave the most desirable flavor. This may have accounted for some inconsistencies in the use levels established for the different products, since more fruit concentrate may have been used in some products than was actually necessary to produce the top flavor intensity.

In the 27 formulas selected by both the professional panel and the consumer panel as best, there should be little question relative to the merit and effectiveness of fruit concentrates and essences in improving the flavor of the finished product.

Certain of the fruit concentrates and essences produced desirable flavor characteristics when used as the only source of flavor. Some of these formulas were not ranked as best and were not presented to the consumer panel, but received desirable rating by the professional panel. The fruit concentrates and essences which produced desirable results when used as the only source of flavor included strawberry juice concentrate, blueberry juice concentrate, grape juice concentrate, grape essence and red raspberry juice concentrate. Flavor cost of this group of products compared favorably with the cost of using fruit.

Extensive investigation in the ice cream phase of the study, the effect of overrun, fat content, type of freezer, and preparation of the fruit, showed that there was little effect of these factors on the flavor properties of ice cream flavored at the various flavoring levels. Results of later investigations indicated that sugar content and acidity level were important in obtaining optimum flavor intensity. Sugar levels of higher than 17% in the base ice cream mix seemed to result in less desirable effects on flavor intensity. The pH value of mixes which resulted in ice cream preferred by the professional panel ranged from 5.2 to 6.2, depending upon the fruit flavor being studied.

Fruit equivalent flavor supplementation ranged from 5% to 20% in the best formulas for ice cream. This was in addition to the use of 20% fruit. The percentage supplementation was calculated as a percentage additional of the 20% used which, in this case, actually amounted to 1 to 4% fruit.

When grape juice concentrate was used as the only source of flavor in ice cream, the amount of concentrate necessary to produce the desired flavor amounted to the equivalent of 35% fruit.

The use of fruit essences and concentrates proved quite effective as flavoring materials for sherbets. Control of the pH of the sherbet mix proved important in gaining the most desired flavor. The pH values ranged from 3.6 to 4.0.

Fruit equivalent flavor supplementation ranged from 15% to 35% in the best formulas for sherbets. This was somewhat higher than for ice cream and it was possible to gain greater fruit intensity in sherbets. The supplementation was in addition to 20% fruit—except in the case of raspberry sherbet where the

supplementation was in addition to 10% fruit. The supplementation actually amounted to 3 to 7% fruit—except in the case of raspberry sherbet, where it was equivalent to 3.5% fruit.

Fruit equivalent flavor supplementation for ices were quite similar to those for sherbets.

The fruit equivalent flavor supplementation was higher for ice milk than for the other products ranging from 25 to 45%, which actually amounted to 3 to 9% fruit.

Fruit concentrates and essences were somewhat less effective as flavoring materials for variegated ice cream.

The cost of flavor supplementation with fruit concentrates or essences ranged from 0.4 to 4 cents per gallon mix for ice cream, from 0.5 to 12.8 cents per gallon mix for sherbets, from 3.3 to 10.5 cents per gallon mix for ices, from 0.7 to 13 cents per gallon mix for ice milk and from 3.1 to 14.8 cents per gallon mix for variegated ice cream. These costs amounted from about 5 to 20% increase in flavor cost in the finished product—except for variegated ice cream where it was 40%.

This publication presents numerous formulas which have considerable potential for utilizing fruit concentrates and essences as flavoring materials for ice cream and related products. The results show that fruit concentrates and essences provide a valuable and economical means of improving the flavor of some flavors of fruit ice cream and related products, as well as a profitable outlet for fruit processed in this form.

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Visitors will be welcome at all times, and will be given every opportunity to inspect the work of the Agricultural Experiment Station in all its departments.

The Bulletins and Reports of the Station will be mailed free of charge to all residents of the State who request them.

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